deprived all at once of its insecure props, settles down to a lower level, a forest perhaps subsiding into a lake, or the sea over-washing a stretch of shore.

Slower processes of change, however, are probably far more general and effective, and with these seismic relations are still in part obscure. Such changes depend, there is little doubt, upon variations of equilibrium between internal forces of expansion and external forces of repression. Where these are accurately balanced, the bounding surface of the earth remains unaltered; where subterranean heat gets the better of gravity, as through the denudation of large tracts, elevation ensues; where the weight of the superincumbent strata is augmented by deposition, there is slow subsidence. The effects of the earth's secular cooling must evidently, in the long run, be thrown wholly into the scale for contraction; and yet it is to them indirectly that the upthrusting of mountain-ranges is due. These might be compared to the folds and creases of a garment grown too ample for the shrunken body it covers. The terrestrial crust, indeed, is less easily adaptable than an old coat; not a wrinkle in it but represents a series of paroxysms, every one implying a greater or less amount of earth-shaking, past and present. The snap after prolonged strain, the shifting and twisting of rocks, the fissuring and faulting, the slipping and wrenching and grinding of tormented strata in the effort to satisfy the stresses put upon them, all result in earthquake action of the mechanical kind. Thus, mountain-making is essentially a seismic operation, not only while in progress, but in its effects during long subsequent millenniums. This is one chief reason why the lines of earthquake distribution follow so faithfully the general direction of mountain-ranges.

But besides those commotions which result from the catastrophic restoration of disturbed equilibrium, there are earthquakes of the volcanic or explosive class. This species has been defined as an "uncompleted effort to establish a volcano." Such abortive eruptions are occasioned, there is much reason to suppose, by the sudden formation of steam at great depths beneath the earth's surface. They arise where broken and disjointed strata facilitate the percolation of water to volcanic foci. A fractured crust and a plentiful aqueous store are their developing conditions. Hence their frequentation of sea-coasts. Prof. Milne remarks that most Japanese earthquakes originate in the Pacific, and that the steepest coasts are, on the whole, the most severely shaken; as is easily intelligible when we consider the violence of the dislocations necessary to produce them.

Earthquakes may then be broadly distributed, according to their kind, into two systems, now coalescing, now independent of each other. The explosive species follow volcanoes along sea-coasts, the mechanical sort are associated with mountain-ranges; all attend lines of weakness, and are more or less closely connected with the shrinkage by cooling of the terrestrial crust. Thus, every volcanic region is liable to earthquakes; though there are earth-shaken districts which are not volcanic.

The tendency to alignment in volcanoes has often been noticed: Prof. O'Reilly indicates a similar peculiarity in earthquakes, adding that the lines along which they range commonly approximate to great circles. This inference, or suspicion, can be verified only by detailed charting. There are great difficulties, however, in getting a true graphical representation of seismic activity. Not only deficiencies in records have to be contended with, but grave perplexities as to their treatment. They are fully admitted by our author. The number of shocks felt in a given spot is the criterion inevitably adopted; but these may vary to any extent in intensity, or may be the mere sympathetic reverberation of some distant catastrophe. The Lisbon earthquake of 1755, for instance, may quite possibly have shaken every square foot of the globe. The ideal seismic map would be one of earthquake origins, with their attendant areas of disturbance; but this is at present far from being attainable; and we can only acknowledge the indebtedness of science to those indefatigable workers who, like Prof. O'Reilly, promote knowledge by the best *present* means open to them.

OUR BOOK SHELF

Department of Agriculture, Washington: Third Report on the Chemical Composition and Physical Properties of American Cereals, Wheat, Oats, Barley, and Rye. By Clifford Richardson. (Washington, 1886.)

THIS Report is an important continuation of a most valuable work. The object in view is to obtain accurate information respecting the composition of the cereal grains produced in the various States. The grain analysed is in some cases the produce of seed issued by the Agricultural Department, but generally represents the ordinary crops of the district. A complete physical and chemical examination has been made of each sample of grain: the results are tabulated under the head of the State in which the grain was reared. The Report contains 77 analyses of different varieties of wheat grown in Colorado; 179 analyses of the kernel of oats, and 100 analyses of the husk; 57 analyses of rye, and 72 of barley. The extent of variation in composition, the relation of physical characters to chemical composition, and the influence of climate, are discussed. The results are further compared with those obtained by investigations in Europe. At the close of the Report are given some detailed analyses of cereal grains in which sugar, starch, and the albuminoids soluble and insoluble in alcohol, are separately determined. Analyses are also given of the very various products obtained from wheat by roller-milling. The whole is a magnificent contribution to the history of cereals. We now know far more of the characteristics of cereals grown on the American continent than we do of those produced in the United Kingdom. When will an English Agricultural Department inaugurate a similar study?

As we have no space for the details of the results, it is perhaps hardly fair to criticise. We would merely remark that dextrin is not reckoned by the best modern chemists among the constituents of barley, or of other cereal grains that have been thoroughly investigated. The method used for determining starch is apparently one yielding too high results, while the "fibre" shown in the analyses is far below the total cellulose and incrusting matter really present. We call attention to these errors of method, as they are very generally met with, and it is high time that they were remedied. R. W.

Longmans' School Geography. By George G. Chisholm, M.A., B.Sc. (London: Longmans, Green, and Co., 1886.)

ONE point which the recent discussions with regard to geographical education in this country has brought out beyond dispute is that our teachers have wretched text-books in geography, and Germany has been held up to us as the model to follow in this as in many other respects in regard to geographical teaching. The Germans (as Mr. Chisholm points out in his interesting preface) have had long experience in working out an advanced system of education; they know that a limited period must be turned to account for the thorough teaching of a great variety of subjects, and accordingly they have learned to distinguish between what is indispensable as a ground-work and what must be omitted. In this country the study of geography is mainly a work of memory—the names of towns, rivers, mountains, with their populations, lengths, and heights. This and similar details are precisely those on which the Germans lay least stress, and as Mr. Chisholm has "earnestly endeavoured to guide himself by German examples," he anticipates that his book will appear more remarkable for what it omits than what it contains. Stated in his own words his object has been, in the first place, to draw a mental picture of the different countries and regions of the world, giving due relief to what is most distinctive in each region, and, secondly, to give special prominence to the relation of cause and effect, so as to enable pupils to realise that in geography there is something to understand as well as to commit to memory, in other words, to make geography a mental discipline as well as a body of instruction. Of course there is important work for the memory in geography as in every other branch of education, and this the author recognises, and provides for in his tables and printing. He insists, too, on the vital necessity of maps, without which there can be no adequate knowledge of geography. A text-book is supplementary to an atlas, and does not supersede it. These are high ideals which Mr. Chisholm sets before him; let us see how he fulfils them.

The whole volume contains 320 pages. The first 60 are devoted to an introduction dealing with mathematical and physical geography, which, as explained in the preface, is designed primarily for teachers, and is not intended to form part of the course for the pupils until they have gone through the whole body of the book.

The introduction is followed by a description of continents and countries. Of the 260 pages which remain for this purpose, Europe fills 150 pages, Asia 45, Africa 16, and America 32. The proportions are based on the degree of knowledge which an educated English boy or man should have of the respective countries and continents. Some of the divisions are original. Thus English counties are divided into corn and grazing, the countries of Asia into monsoon and non-monsoon countries. We have specially examined the sections devoted to the countries of Eastern Asia, for the sins of ordinary British school geographies are more apparent here than elsewhere—the sins, namely, of stereotyped inaccuracy, and of strings of names and numbers. Mr. Chisholm has not a superfluous line in any of these sections, the information is of the latest kind, and all the knowledge that the average boy requires of the countries is put in a short space.

As an instance of the care with which the work is done it may be mentioned that the puzzling variations of some Japanese names (*e.g.* Fujinoyama, Fujisan) are given and explained. On the whole, we are convinced that there is at present no school geography in the English language more calculated to give adequate and intelligent instruction in that subject than this, and can therefore strongly recommend it to those teachers who have lamented the absence of a sound text-book. It is to be hoped that Mr. Chisholm may see his way to producing a smaller work about half the size and price of this book for lower classes.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Physiological Selection and the Origin of Species

As Mr. Romanes has referred to my article in the current number of the *Fortnightly Review*, and stated that he is prepared to answer what he terms "the very obvious exceptions" which I have taken to his theory, I shall be glad to be allowed to state, very briefly, what those exceptions are, and to give an illustration of one of the more important of them.

(1) Mr. Romanes makes a great deal of the alleged "inutility of specific characters," and founds upon it his extraordinary statement that, during his whole life, Darwin was mistaken in supposing his theory to be "a theory of the origin of species," and that all Darwinians who have believed it to be so have blindly fallen into the same error. I allege, on the contrary, that there is no proof worthy of the name that specific characters are frequently useless, and I adduce a considerable series of facts tending to prove their general utility.

(2) In support of his view as to the swamping effects of inter-crossing, Mr. Romanes objects to the assumption of Darwin, "that the same variation occurs simultaneously in a number of individuals," adding: "Of course, if this assumption were granted, there would be an end of the present difficulty"; and his whole argument on this branch of the question rests on the assumption being false. I adduce evidence—copious evidence—that the supposed assumption represents a fact, which is now one of the best-established facts of natural history.

(3) Mr. Romanes states, as the special feature of his physiological varieties, that "they cannot escape the preserving agency of physiological selection." He gives no particle of proof of this, while I show that, on the contrary, it is hardly possible for them to survive to a second or third generation. It is on this point that I wish to give an illustration. Mr. Romanes speaks of his supposed variations as "showing some degree of sterility with the parent form," while continuing to be fertile "within the limits of the varietal form"; but I hold that any such variety (beyond single individuals) can hardly exist, while he has adduced no proof whatever of their existence. To show the improbability of their existence, let us suppose a definite case.

In a given species there is born an individual, A, which is infertile with the bulk of the species, but fertile with some few individuals of the opposite sex, *a*, *b*, *c*. Let there be a second individual, E, born from other parents in another part of the area occupied by the species, and fertile only with *e*, *f*, *g*. Other individuals, K, P, R, &c., may have similar relations, each infertile with the bulk of the species, fertile only with a few individuals which may be termed their physiological complements. Now each of these, separately, is a physiological variety, but the whole set, A, E, K, P, R, do not form one, but five distinct varieties. To form one variety all of them must be fertile with the same identical set of individuals of the opposite sex, and this seems to me to be so highly improbable that it must not be assumed till rigidly proved. Yet there is not one passage in Mr. Romanes' paper to show that he recognised this difficulty; on the contrary, he always speaks as if any number of separate physiological variations within one species must necessarily form one variety. It will easily be seen that the chances against any single variety of this nature being preserved are overwhelmingly great. For, first, at least two of the complementary individuals must survive to the breeding-season, and the chances against this are measured by the fertility of the species. If it produces ten young each year, the chances are between nine and ten to one against any one of them surviving. The chances against the *two* complements surviving will be about ninety to one; and then there remains the chances against the two meeting at the breeding-season, for, by the assumption, there is nothing whatever to bring them together but chance, and this may be any number of thousands to one.

There are, no doubt, other possible cases in which the physiological variety might be continued, but, as I have shown in my